REMARKS

Summary of Response to Office Action

Claims 1, 3, and 9 are amended to distinguish the components of an Automotive Ball System from those associated with the Wachspress levitating device. Claim 2 is cancelled as its essence is preserved in other more explicit claims. Claims 4 and 5 are amended to retain their original meaning while complying with the substitution of their former base claim, claim 2, with amended claim 3. Claim 16 is not amended as it is now dependent on an amended claim that redefines the scope of claim 16. All other claims were otherwise allowable, except for dependence on rejected base claim. The base claim has been amended; dependent claims are therefore held as rectified.

Details with References

Claim 1

Points of emphasis in the amendments to claim 1 are a) the nature of the electromagnets employed in an automotive ball and b) a specific physical organization of these electromagnets within an automotive ball. These points are discussed and then followed with references in the original application and in the Wachspress patent.

Automotive balls employ conventional electromagnets, whereas the Wachspress levitating device makes use of "odd-pole electromagnets." Distinctions are made between conventional electromagnets and the odd-pole electromagnets required for the operation of the Wachspress device. Conventional electromagnets consist of one electrical coil having two electrical connections to a power supply, one positive and one negative. Further, a conventional electromagnet exhibits only two poles, one north pole and one south pole.

In contrast, the tripole and other odd-number pole magnets disclosed by Wachspress are intended to have a configuration where the total number of north poles is greater than the total number of south poles, or vice versa (FIG. 1, FIG. 4). These electromagnets are constructed by associating multiple electrical coils that, as one unit, have three or more electrical connections to a power supply (FIG. 2B, FIG. 3, FIG. 15).

Conventional electromagnets would fail to perform all the operations of the Wachspress levitating device, and thus odd-pole electromagnets are required. Automotive ball operation, on the hand, does not rely on the features of an odd-pole construction in order to operate but instead employs simple conventional electromagnets. The Wachspress disclosure in fact distinguishes its levitating device, which requires odd-pole electromagnets, from most other "magnetomechanical devices" (col. 1, lines 59-61; col. 10, lines 21-4). References stating requirement of odd-pole electromagnets are numerous and include

- claim 1: "pair of...magnet windings...with the small diameter ends contiguous to form a tripole magnet";
- claim 2: "a second pair of...magnet windings...with the small diameter ends thereof contiguous to form a second tripole magnet";
- col. 1, lines 21-2: "present invention provides for establishing an interacting tripole magnetic field"; and
- col. 1, lines 33-34: "a levitator or flight unit incorporating a number of magnets having an odd number of poles".

Claim 1of the automotive ball application is amended to state explicitly the features of conventional electromagnets as opposed to odd-pole constructions according to Wachspress. The requirements for one north pole and one south pole and one electrical coil having only two electrical connections do not constitute new matter with respect to the original automotive ball system (ABS) application. A typical electromagnet is well understood in the fields of electrical engineering and physics to have all of the features of the above requirements.

A further new requirement of claim 1 is that the electromagnets of an automotive ball are removed from the center space of the automotive ball by some radial distance, as shown in FIG. 4 and FIG. 5. In lines 241-2, the electromagnets are said to be arranged like points on a spherical surface. A point on the surface of a sphere is located away from the center of the sphere by a distance that is equal to the radius of the sphere. Other references are lines 89 and 185; here the electromagnets are described as positioned on an inner layer and positioned close to the exterior surface, respectively.

This geometrical configuration of the electromagnets within an automotive ball confers several features to the automotive ball including

- Odd-pole electromagnets of the form described by Wachspress cannot be constructed in an automotive ball. The odd-pole electromagnets of Wachspress are formed by physically joining two or more two-pole electromagnets "as close together as possible" (col. 5, lines 59-62; col.1, lines 40-42; claims 1, 2, 12). In the automotive ball construction, any two diametrically opposite electromagnets are separated by a distance of $2r_{em}$ and thus cannot form tripoles.
- Unlike in the Wachspress levitating device, the electromagnets of an automotive ball do not meet at the interior of the sphere (ABS FIG. 4, FIG. 5), thereby avoiding a crowded interior. This construction greatly reduces undesirable current induction (interference) between electromagnets that would result from crowding. Therefore, the electromagnets of an automotive ball can better operate independently.
- Since electromagnets in an automotive ball are located close to the outer surface of the automotive ball and do not extend into its interior, many more electromagnets can be embedded into an automotive ball. In other words, a sphere can accommodate a larger number of radially configured objects the farther away the objects are from the center of the sphere. A high number of electromagnets permits fine control of the rolling motion of an automotive so that its movement is smooth, continuous, and non-jerky.
- As shown in Wachspress FIG. 1, the central interior space of the levitating sphere is occupied by the tripole electromagnets. In contrast, the configuration of electromagnets in an automotive ball makes the central space available. As shown in ABS FIG. 5 and described in lines 182-193, this central space is strategically employed to implement a light-collecting center (LCC) with its associated optical fiber network. This fiber network is radially symmetrical, thereby avoiding weight imbalance that would result if the LCC were not located at center. In other words, one side of the automotive ball would be heavier than the opposite side if the LCC is not centered, which would result

in spontaneous rolling in order to lower the heavy side while elevating the lighter side. It is not intended, however, that such spontaneous motion should occur. An automotive ball should remain stationary until one or more of its electromagnets is activated (lines 29-31).

- Further, a radially symmetrical optical fiber network has a simple design that is less challenging and more practical to manufacture compared to a complicated design that would be required if the LCC were not located at the center of the automotive ball.

Claim 2

Cancel claim 2. Other more specific claims preserve the essence of claim 2.

Claim 3

The means through which an automotive ball produces rolling motion differ fundamentally from the elements of the Wachspress levitating device. Claim 3 is amended to underline these differences. In summary, an automotive ball contains conventional even-pole electromagnets that interact with only one pole of an external magnet; whereas the Wachspress levitator employs odd-pole electromagnets within the device that interact with both poles of an external magnet. Further, the Wachspress disclosure, aimed at a levitating device, does not provide for a magnetic plane on which the device may locomote but in fact makes use of a non-magnetic surface (col. 4, lines 1-2). The structure and advantages of the magnetic planes of an ABS are discussed below.

A key point of claim 3 is the structure of the magnetic planes on which automotive balls rolls. An automotive ball rests on one side of a magnetic plane, where this side of the plain is either the north pole or south pole, but not both. This arrangement is contrasted to that of the Wachspress levitator where both poles of an external magnet are available to the levitating device (Wachspress FIG. 1; claim 1; and other references).

The roof 23 and floor 24 of the ABS motion environment together with their respective underlying magnets 8 and 13 are examples of magnetic planes according to claim 3. These particular magnetic planes are formed by associating either the north pole(s) or south pole(s) of a magnet(s) with one side of a surface. Automotive

balls roll on the opposite side of this surface (FIG. 1, FIG. 2, lines135-7). Such magnetic planes expose automotive balls to only one pole of the underlying magnet(s).

This exposure to a single magnetic pole is advantageous in the process of DCEPE, or displacement of contact electromagnet(s) by proximate electromagnet(s). An automotive ball rolls on a magnetic plane via DCEPE, which is described in lines 165-181 and illustrated in FIG. 4A-C. The advantage of a one-pole magnetic plane is best understood by reviewing the process of DCEPE as follows.

In FIG. 4A, electromagnet 7 is a "contact electromagnet" as it is the closest electromagnet to the contact point between the automotive ball and the magnetic plane (depicted as magnet 13). Electromagnet 6 is a "proximate electromagnet" as it is close to the contact point, but not as close as electromagnet 7. In the transition from FIG. 4A to FIG. 4B, electromagnet 6 displaces electromagnet 7 such that electromagnet 6 is no longer a proximate electromagnet but is now a contact electromagnet (FIG. 4B). Similarly, electromagnet 7 is no longer a contact electromagnet but has become a proximate electromagnet (FIG. 4B). This transition is accomplished by the rolling motion of the automotive ball, as motivated by the attraction of proximate electromagnet 6 (FIG. 4A) to the magnetic plane. This process may be repeated indefinitely with any proximate electromagnet(s) so as to produce continued rolling motion in any respective direction.

Thus, the process of DCEPE involves the attraction of proximate electromagnets in an automotive ball to a magnetic plane. It is not necessary to reverse the polarity of the proximate electromagnets in order to maintain attraction to the magnetic plane, since the electromagnets interact with only one pole of the magnetic plane. In contrast, if the magnetic plane were to have two or more regions of different polarities on the same side of the plane (ex. Wachspress FIG. 1 showing magnet with north and south poles), it would be necessary to determine changes in polarity when the automotive ball rolls from one area of the surface to another. Such determinations would be necessary in order to reverse the polarity of proximate electromagnets so as to maintain attraction to the magnetic plane and avoid repulsion. In the Wachspress configuration (FIG. 1), it would also be necessary to vary the

electric current flow in the electromagnets so as to compensate for the changing external field strength when an automotive rolls between north and south poles. All these complications are eliminated by implementing a one-pole magnetic plane.

The Wachspress device, in its normal and usual mode of operation, is a levitator (col. 14, lines 18-19, 4-7; col. 13, lines 60-68; col. 1, lines 15-17; col. 8, lines 38-42, etc.) and is not equipped to roll on a surface via DCEPE. For example, Wachspress does not disclose means for determining changes in magnetic surface polarity, as would be necessary for performing continuous, omni-directional DCEPE on a multi-pole magnetic surface. Also, Wachspress does not disclose sequential activation of surface-proximate electromagnets as directed towards causing rolling motion on a magnetic surface.

Columns 7 and 8 of the Wachspress disclosure describe rotational movements of the Wachspress levitator, as cited in the office action. These rotational movements, however, are not equivalent to automotive ball rolling. In the ABS disclosure, rolling occurs by DCEPE, whereas the Wachspress device employs tripole electromagnets that become aligned with the external magnetic field (col. 7, lines 56-63). Further, the exemplary embodiment of the Wachspress levitator (FIG. 1) does not permit rolling motion. First, the device is not in contact with a magnetic plane, which is necessary for DCEPE, but is in fact suspended above a bar magnet by a tether. This tether also will not permit rolling motion where the axis of rotation is perpendicular to the axis of the tether, as would be necessary for rotational motion that actually translates the device to a new position in space. Additionally, the Wachspress levitator of FIG. 1 contains only four magnetic windings. This low density of electromagnets leaves large surface areas of the ping-pong ball that do not have underlying electromagnets. As a result, it is possible for the device to be oriented in such a way that there are no proximate electromagnets to perform DCEPE.

In conclusion, the process of continuous DCEPE and the associated apparatus are novel and distinct from prior art.

Claims 4 & 5

Claims 4 and 5 are no longer dependent on claim 2, which has been cancelled, but are instead dependent on the currently amended claim 3. The methods of levitation and

descent employed in the ABS are distinguished from those employed by the Wachspress levitator. Levitation of an automotive ball is accomplished by activating conventional even-pole electromagnets in the automotive ball such that they have like poles with the magnetic plane on which the automotive ball rests. The automotive ball is thereby repelled from the magnetic plane. By reversing the direction of electric current flow in the electromagnets, the automotive ball then exhibits opposite magnetic polarity to the magnetic plane, causing an attraction and therefore descent of the automotive ball toward the plane. Such vertical levitation and descent is possible because the magnetic planes of an ABS expose only one pole (north only or south only) to automotive balls. If two or more poles were exposed (ex. Wachspress FIG. 1), an automotive ball would migrate toward a pole of unlike polarity instead of levitate.

Claim 9

Claim 9 is amended to emphasize that sources of external magnetic field are magnetic planes that have a structure described in claim 3, where this structure differs from the arrangement in the Wachspress system.

Claim 16

Claim 16 remains in its original form but is dependent on currently amended claim 1. Fluctuating magnetic fields are not unique to the Wachspress device. According to general principles, any conductor that passes time-variable current also generates fluctuating magnetic fields. For example, sound speakers, which are electromagnets, are used in a variety of novel technologies. AC transformers are another example of electrical devices that generate fluctuating magnetic fields and are employed in new inventions. Thus what is claimed in claim 16 is not the general ability of any electrical device to generate fluctuating magnetic fields but specifically the ability of automotive balls to actively generate such fields via the embedded electromagnets.

Claims 6-8, 10-15, and 17-20

The base claim and any applicable intervening claims are currently amended and should rectify the status of the above claims.

CHANGE OF ADDRESS & SIGNATURE

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The above amendments to patent application no. 10/771,084 titled "Automotive Ball System" are hereby approved by the applicant.

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